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Lost Opportunities: Radiologists Are Not Sufficiently Using Reduced-Dose CT for Kidney Stones[1]

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Unenhanced computed tomographic (CT) imaging has emerged as the most accurate and widely used test for patients with known or suspected kidney stones (1). The American College of Radiology (ACR) appropriateness criteria for imaging acute onset of flank pain or suspicion of kidney stone disease recommend CT with reduced radiation dose as the appropriate imaging modality (2). Reduced-dose CT scan protocols for kidney stones, usually at an effective dose at or less than 3 mSv, have been shown to be accurate (3). This is true because the challenge for CT imaging in patients with kidney stones is relatively simple: To detect a high-density object (urinary stone) surrounded by low-density tissue (renal pelvis, ureter, and fat).

In this issue of *Radiology*, Weisenthal and colleagues (4) determined the extent of the use of reduced-dose CT for evaluating kidney stones by querying a national dose registry, hereby comparing the data from 2015–2016 to rates from 2011–2012. The authors found an increase of 5.6% in the use of reduced-dose protocols compared with that during the previous period. The mean overall dose-length product (DLP) decreased from 746 mGy · cm in 2011–2012 to 689 mGy · cm in 2015–2016, while considerable variability remained (from < 200 mGy · cm to > 1600 mGy · cm per CT examination). Thus, the utilization rate of reduced-dose CT for kidney stone evaluation increased over the studied period, which can be attributed to an increased awareness of radiologists regarding radiation, advances in CT technology, current recommendations of the ACR, and literature demonstrating the accuracy of reduced-dose CT protocols. However, the proportion of CT examinations for kidney stones performed with reduced-dose protocols remains disappointingly low. Of note, in less than one-third of these CT examinations was a DLP less than 400 mGy · cm used, which is still twice the recommended radiation dose (3). Nearly 20% of the kidney stone CT examinations studied by Weisenthal and colleagues (4) had DLPs greater than 1000 mGy · cm (equaling effective doses > 15 mSv), which is five times the recommended radiation dose for evaluation of kidney stone disease.

These findings indicate that careful review of institutional urinary stone protocols is warranted to ensure better coherence to the "as low as reasonably achievable," or ALARA, principle in medical imaging in which ionizing radiation is used. Programs and campaigns for promoting the use of reduced-dose protocols already exist, such as the Image Wisely campaign, (*http://www.imagewisely.org*) established by the ACR in conjunction with the Radiological Society of North America, the American Association of Physicists in Medicine, and the American Society of Radiologic Technologists (5), but further education appears to be mandatory to obtain more widespread and substantial dose reductions at CT.

One could argue against this presumed underutilization of reduced-dose protocols that many of the most effective dose-reduction techniques such as iterative reconstructions and low tube voltage scanning require newer CT scanner technology. It cannot be expected that facilities purchase new CT scanners and/or software packages in the relatively short time period studied by Weisenthal and colleagues (4), and thus it is not feasible to expect a larger increase in the utilization rate of reduced-dose CT examinations for kidney stones. Such an argument is further corroborated by results of a recent survey showing that the age profile of installed CT systems has worsened in the past 5 years, while the age profiles

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See also the article by Weisenthal et al in this issue.

of other advanced imaging modalities such as magnetic resonance (MR) imaging and fluoroscopic units have remained stable (6). In this survey of institutions in several European countries, more than half of currently installed CT systems were 6 years old and older, and the number of countries with 10% of their CT systems older than 10 years has tripled in the past 7 years. In addition, approximately one-quarter of the installed CT bases are too old to upgrade with the new technologies, which makes them suboptimal from a dose optimization and dose reduction point of view. However, this result contradicts those of a meta-analysis from Niemann and colleagues (7) study indicating that reduced-dose CT protocols for kidney stone evaluation with an effective dose less than 3 mSv are highly accurate (pooled sensitivity and specificity, 0.97 and 0.95, respectively), with CT technology between 2000 and 2007. This indicates that dose reduction is possible even without having the newest CT scanner technology available. Certainly, it remains unclear from the available data of this study (4) which of the many available dose reduction techniques were (or were not) applied.

On the basis of the design of the Dose Index Registry, the database used in this study (4), DLP values were the descriptors for describing and reporting CT dose metrics. Use of the DLP has some known limitations. Compared with the volume CT dose index, the DLP inherently includes the scan length and thus shows variability across examinations. In addition, the DLP is dependent on the over-ranging effect at helical CT, which is scanner and protocol dependent. This effect is more pronounced with newer CT systems that have a wider total beam collimation (8). Another descriptor of dose is the size-specific dose estimate, which accounts for patient size and thus allows exclusion of variations in body mass index of the study population. Use of the size-specific dose estimate instead of the DLP can normalize dose distribution and reduce variability in median values. However, as noted by the authors, size-specific dose estimate was not available in the Dose Index Registry. The authors calculated the size-specific dose estimate by using the scout images, when available. This approach has potential pitfalls because the vertical position of the patient and tube projection angle considerably influences patient size on scout images (9).

One of the main challenges of such endeavors with collection of data from a large number of diverse institutions is the variability in CT protocol names, which differ across (and perhaps even within) the various sites. It is likely that some of the unenhanced abdominal and pelvic CT examinations in the database were used not for evaluation of kidney stones but for other indications. This may account for some of the high-dose outliers in the DLP histogram presented by the authors (4).

Besides CT imaging of the lung, there are not many CT indications in which radiation dose can be optimized and lowered to a greater extent than that for the evaluation of urinary stone disease. This is due to the large set of techniques that enable radiation dose lowering at CT and to the nature of the examination: Depiction of high-density structures in a region of the body with low attenuation that share characteristics with coronary calcium scoring. It is thus even more troublesome that the many existing options for sufficient use of reduced-dose CT for kidney stones are not used far more frequently. It appears that part of the radiologic community lost some opportunities in recent years, and articles such as that by Weisenthal et al (4) should motivate us to further improve our radiologic practice today and in the near future.

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